TRAINABLE TRANSCEIVER SYSTEM

BACKGROUND

[0001] In the field of wireless control of home and office electronic systems, technological advances have been developed to improve convenience, security, and functionality for the user. One example is a trainable transceiver for use with various home and office electronic systems, such as security gates, garage door openers, lights, and security systems. A user trains the trainable transceiver by, for example, transmitting an activation signal from a remote controller (e.g., an original transmitter) in the vicinity of the trainable transceiver. The trainable transceiver learns the carrier frequency and control data of the signal and stores this code for later retransmission. In this manner, the trainable transceiver can be conveniently mounted within a vehicle interior element (e.g., visor, instrument panel, overhead console, etc.) and can be configured to operate one or more home electronic systems.

[0002] Further advances are needed in the field of wireless control of home electronic systems, particularly in the case of using automotive electronics to control home electronic systems. As automotive manufacturers are adding increased electronic systems to the vehicle to improve convenience, comfort, and productivity, simplifying the interface and control of these electronic systems is also becoming increasingly important.

[0003] One limitation on the usefulness of a trainable transceiver is that it is fixedly coupled to a vehicle interior element, which limits the uses that the trainable transceiver can provide. Although trainable key fobs have been proposed, such key fobs typically require additional circuitry which adds to cost, consumes space and increases power consumption. Accordingly, what is needed is a smaller and more portable transmitter, such as a key fob, which can be trainable. Further, what is needed is a low-cost portable transmitter that improves the convenience and functionality of a trainable transceiver system. Further still, what is needed is a system and method of training a portable trainable transmitter.

[0004] There is also a need for a trainable transceiver system that uses low-cost components such as optical components. Optical transmissions can be less susceptible to noise and may provide more data in a given time period than other transmissions. Further still, there is a need for a trainable transceiver system which efficiently utilizes existing optical components for additional functions.

[0005] The teachings hereinbelow extend to those embodiments which fall within the scope of the appended claims, regardless of whether they accomplish one or more of the above-mentioned needs.

SUMMARY

[0006] According to an exemplary embodiment, a trainable transceiver system comprises a trainable transceiver and a portable transmitter. The trainable transceiver is fixedly coupled to a vehicle interior element. The trainable transceiver is configured to receive a characteristic of an activation signal, to store the activation signal characteristic in a memory, and to retransmit the activation signal characteristic via an optical transmission. The portable transmitter is configured to receive the characteristic of the activation signal from the trainable transceiver via the optical transmission, to store the activation signal characteristic, and to retransmit the stored activation signal characteristic. The characteristic can comprise control data configured to actuate a remote device. The control data can be configured to actuate a garage door opener. The control data can comprise a cryptographically-encoded control data.

[0007] The trainable transceiver can further comprise an optical transmitter configured to transmit the characteristic of the activation signal via an optical signal or a light signal. The portable transmitter can comprise an optical receiver configured to receive the light signal. The optical transmitter can be a light-emitting diode.

[0008] The portable transmitter can comprise a housing configured as a key fob. The trainable transceiver can be configured to store the frequency and control data of the activation signal. The portable transmitter can be configured to receive the frequency and control data characteristics retransmitted by the trainable transceiver. The trainable transceiver can further be configured to receive remote keyless entry data from a remote keyless entry transmitter, to store the remote keyless entry data, and to retransmit the remote keyless entry data to the portable transmitter. The remote keyless entry transmitter can comprise a housing configured as a key fob. The trainable transceiver can be configured to wirelessly receive an activation signal and to determine the characteristic to be stored based on the activation signal.

[0009] In accordance with another embodiment, the trainable transceiver may be configured to retransmit the characteristic of the activation signal via an RF transmission

and the portable transmitter is configured to receive the characteristic of the activation signal from the trainable transceiver via the RF signal. The portable transmitter can comprise a broadband radio frequency receiver circuit configured to receive the retransmitted characteristic of the activation signal on any of a plurality of frequencies. Alternatively, the portable transmitter can comprise a fixed radio frequency receiver circuit configured to receive the retransmitted characteristic of the activation signal on any of a plurality of frequencies.

[0010] According to another exemplary embodiment, a trainable transceiver comprises a housing, a control circuit, and an optical transmitter. The housing is fixedly coupled to a vehicle interior element. The control circuit is coupled to the housing and is configured to receive a characteristic of an activation signal and to store the characteristic in a memory. The optical transmitter is configured to transmit the characteristic via an optical signal. The trainable transceiver can further comprise a receiver circuit configured to wirelessly receive the characteristic of the activation signal. The trainable transceiver can further comprise an operator input device coupled to the control circuit, wherein the control circuit is configured to receive the characteristic of the activation signal from the operator input device.

[0011] According to another exemplary embodiment, a trainable key fob comprises a housing, an optical receiver, a control circuit, and a wireless transmitter. The housing is configured as a key fob. The optical receiver is configured to receive an optical signal comprising a characteristic of a wireless activation signal. The control circuit is configured to store the characteristic in a memory. The wireless transmitter is configured to retransmit the stored activation signal characteristic. The control circuit can be configured to receive characteristics of the wireless activation signal comprising the frequency and control data of the activation signal. According to an alternative embodiment, components for a wired connection can replace the optical components.

[0012] According to yet another exemplary embodiment, a trainable key fob comprises a housing configured as a keyfob, an RF receiver configured to receive an RF signal comprising a characteristic of a wireless activation signal, a control circuit configured to store the characteristic in a memory and a wireless transmitter configured to retransmit the stored activation signal characteristic. The RF receiver may be a broadband receiver or a narrowband receiver.

[0013] According to another exemplary embodiment, a trainable transceiver comprises a housing, a control circuit and an RF transceiver. The housing is fixedly coupled to a vehicle interior element. The control circuit is coupled to the housing and is configured to receive a characteristic of an activation signal and to store the characteristic in a memory. The RF transceiver is configured to learn the characteristics of the activation signal and to transmit data representing the characteristic via an RF signal.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] The invention will become more fully understood from the following detailed description, taken in conjunction with the accompanying drawings, wherein like reference numerals refer to like parts, and in which:

[0015] FIG. 1 is a perspective view of a vehicle having a trainable transceiver system, according to an exemplary embodiment;

[0016] FIG. 2 is a block diagram of a trainable transceiver system and a home electronic system, according to an exemplary embodiment; and

[0017] FIG. 3 is a schematic diagram of a visor having a trainable transceiver fixedly coupled thereto, according to an exemplary embodiment.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0018] Referring first to FIG. 1, a vehicle 10, which may be an automobile, truck, sport utility vehicle (SUV), mini-van, or other vehicle, includes a trainable transceiver system 11 comprising a trainable transceiver 12 and a portable transmitter 13. Trainable transceiver 12, the exemplary embodiments of which will be described hereinbelow, is illustrated fixedly coupled to or mounted to an overhead console of vehicle 10. Alternatively, one or more of the elements of trainable transceiver 12 may be mounted to other vehicle interior elements, such as, a visor 14 or instrument panel 16. Portable transmitter 13 comprises a housing configured as a key fob, keychain, or other handheld device. A key fob is a handheld device providing a keyed or wireless (e.g., via remote keyless entry) access to a vehicle.

[0019] Referring now to FIG. 2, trainable transceiver system 11 is illustrated along with a home electronic system 18 which may be any of a plurality of home electronic systems,

such as, a garage door opener, a security gate control system, security lights, home lighting fixtures or appliances, a home security system, etc. For example, home electronic system 18 may be a garage door opener, such as the Whisper Drive™ garage door opener, manufactured by the Chamberlain Group, Inc., Elmhurst, Illinois. Home electronic system 18 may also be a lighting control system using the X10 communication standard. Home electronic system 18 includes an antenna 28 for receiving activation signals including control data which will control home electronic system 18. The activation signals are preferably in the ultra-high frequency (UHF) band of the radio frequency spectrum, but may alternatively be infrared signals or other wireless signals.

[0020] Trainable transceiver 12 includes a control circuit 30 configured to control the various portions of system 12, to store data in memory, to operate preprogrammed functionality, etc. Control circuit 30 may include various types of control circuitry, digital and/or analog, and may include a microprocessor, microcontroller, application-specific integrated circuit (ASIC), or other circuitry configured to perform various input/output, control, analysis, and other functions to be described herein. Control circuit 30 is coupled to an operator input device 32 which includes one or more push button switches 34 (see FIG. 3), but may alternatively include other user input devices, such as, switches, knobs, dials, etc., or even a voice-actuated input control circuit configured to receive voice signals from a vehicle occupant and to provide such signals to control circuit 30 for control of system 12. Trainable transceiver 12 further includes a memory 74, which may be a volatile or non-volatile memory, and may include read only memory (ROM), random access memory (RAM), flash memory, or other memory types.

[0021] Control circuit 30 is further coupled to an optical transmitter 38, which includes a light-emitting diode (LED) in this exemplary embodiment. Optical transmitter 38 may alternatively include other display elements, such as a liquid crystal display (LCD), a vacuum florescent display (VFD), etc.

[0022] Trainable transceiver 12 further includes a transceiver circuit 54 including transmit and/or receive circuitry configured to communicate via antenna 56 with home electronic system 18. Transceiver circuit 54 is configured to transmit wireless control signals having control data which will control home electronic system 18. Transceiver circuit 54 is configured, under control from control circuit 30, to generate a carrier frequency at any of a number of frequencies in the ultra-high frequency range, preferably between 260 and 470

megaHertz (MHz), wherein the control data modulated on to the carrier frequency signal may be frequency shift key (FSK) or amplitude shift key (ASK) modulated, or may use another modulation technique. The control data on the wireless control signal may be a fixed code or a rolling code or other cryptographically encoded control code suitable for use with home electronic system 18.

[0023] Referring now to FIG. 3, an exemplary trainable transceiver 12 is illustrated coupled to a vehicle interior element, namely a visor 14. Visor 14 is of conventional construction, employing a substantially flat, durable interior surrounded by a cushioned or leather exterior. Trainable transceiver 12 is mounted or fixedly coupled to visor 14 by fasteners, such as, snap fasteners, barbs, screws, bosses, etc. and includes a molded plastic body 58 having three push button switches disposed therein. Each of the switches includes a respective back-lit icon 40, 42, 44. Body 58 further includes a logo 60 inscribed in or printed on body 58 and having an optical transmitter 38 disposed therewith. During training and during operation, optical transmitter 38 is selectively lit by control circuit 30 (FIG. 2) to communicate certain information to the user, such as, whether a training process was successful, whether the control system 12 is transmitting a wireless control signal, etc. The embodiment shown in FIG. 3 is merely exemplary, and alternative embodiments may take a variety of shapes and sizes, and have a variety of different elements.

[0024] In operation, trainable transceiver 12 is configured to receive one or more characteristics of an activation signal sent from an original transmitter 102. Original transmitter 102 is a transmitter, typically a hand-held transmitter, which is sold with home electronic system 18 or as an after-market item, and which is configured to transmit an activation signal at a predetermined carrier frequency and having control data configured to actuate home electronic system 18. For example, original transmitter 102 can be a hand-held garage door opener transmitter configured to transmit a garage door opener signal at a frequency, such as 355 megaHertz (MHz), wherein the activation signal has control data, which can be a fixed code or a cryptographically-encoded code. Home electronic system 18 is configured to open a garage door, for example, in response to receiving the activation signal from original transmitter 102.

[0025] Trainable transceiver 18 is configured to receive one or more characteristics of the activation signal from original transmitter 102 or from another source, which characteristics can include the frequency, control data, modulation scheme, cryptographic algorithm, etc.

In this embodiment, trainable transceiver is configured to learn at least one characteristic of the activation signal by receiving the activation signal, determining the frequency of the activation signal, and demodulating the control data from the activation signal. Trainable transceiver 12 can be a Homelink™ trainable transceiver, manufactured by Johnson Controls Interiors LLC, Holland, Michigan, and may be constructed according to one or more embodiments disclosed in U.S. Patent No. 5,614,891, 6,091,343, 5,854,593 or 5,708,415, which are herein incorporated by reference in their entirety. Alternatively, trainable transceiver 12 can be replaced with a transmitter or transceiver configured for other methods of learning or determining the characteristics of the activation signal, such as, a scanning receiver, a broadband RF detector, user input selection, a "trial and error" selection of known systems or other methods. For example, the one or more characteristics of the activation signal can be preprogrammed into memory 74 during manufacture of trainable transceiver 12 or can be input via operator input device 32 (which can include a key pad, buttons, etc.). In this manner, trainable transceiver 12 need not actually receive the activation signal in order to obtain the characteristics of the activation signal. Trainable transceiver 12 can receive the characteristics of the signal by any of these methods and store the characteristics of the activation signal in memory 74.

[0026] Referring again to FIG. 2, portable transmitter 13 is shown in block diagram form. Portable transmitter 13 comprises a control circuit 104, which can include one or more components of control circuitry described with reference to control circuit 30. Portable transmitter 13 further comprises an operator input device 106, a transmitter circuit 108, and a receiver circuit 110. The receiver circuit is configured to receive data from the trainable transceiver including one or more characteristics of the original transmitter. In this embodiment, trainable transceiver 12 is configured to transmit one or more characteristics of the activation signal to portable transmitter 13. Trainable transceiver 12 can transmit the activation signal itself (i.e., using the carrier frequency and control data of the activation signal), or trainable transceiver 12 can transmit the one or more characteristics of the activation signal using any other transmission frequency, data code, modulation scheme, or other signal characteristic. In this embodiment, trainable transceiver 12 is configured to modulate control data of the activation signal (and/or other data code characteristics) onto a light signal by controlling optical transmitter 38 to transmit the light signal. Preferably, the control code is modulated at a high enough frequency (e.g., at least 38 kHz, 40 kHz, or 455 kHz) such that the light signal appears to be steadily lit to the human eye.

[0027] Optical transmitter 38 can be a light-emitting diode, and can serve both functions of communicating above with the operator during training of trainable transceiver 12, as described herein, and/or optical transmitter 38 can be used to transfer one or more characteristics of the activation signal from original transmitter 102 to the portable transmitter 13. Portable transmitter 13 is configured to receive the characteristics of the activation signal from trainable transceiver 12 and to store the characteristics in a memory 112 for later use. Portable transmitter 13 can retransmit the stored activation signal characteristic, preferably as the activation signal itself, having the proper frequency and control data, to home electronic system 18 to activate home electronic system 18.

[0028] According to one exemplary embodiment, trainable transceiver 12 modulates a data packet on to the light signal transmitted by optical transmitter 38 every time trainable transceiver 12 transmits an activation signal via transceiver circuit 54. Typically, this occurs in response to operator actuation of operator input device 32, but other events can trigger the transmission, such as the location of the vehicle, time of day, etc.

[0029] Portable transmitter 13 comprises a receiver circuit 110, which can be an optical receiver or photo sensor configured to receive and decode the light signal itself or under control of control circuit 104. For example, a TSOP7000 (455 kHz) or TSOP 2240, manufactured by Vishay Semiconductor GmbH, Heilbronn, Germany can be used. In this embodiment, every time a button on operator input device 106 is activated, receiver circuit 110 is configured to receive an optical signal from optical transmitter 38 at a predetermined transmission rate and modulation format. Alternatively, portable transmitter 13 is configured to default to a receive mode wherein receiver circuit 110 is configured to receive the light signal from optical transmitter 38. If receiver circuit 110 detects a signal from trainable transceiver 12, receiver circuit 110 receives the signal and control circuit 104 is configured to store the activation signal characteristic(s) in memory 112 for use the next time operator input device 106 is actuated.

[0030] Alternatively, trainable transceiver 12 and portable transmitter 13 can be configured to communicate via an electrical connection, such as a wired connection, wherein trainable transceiver 12 would further include a connection port for data (not shown and receiver circuit 110 would be replaced with a connection port for data, an ultrasonic transmission, wherein optical transmitter 38 and receiver circuit 110 are replaced with sonic or ultrasonic transducers, an inductive coupling, wherein optical transmitter 38 and receiver

circuit 110 are replaced with inductive windings, a capacitive technique, wherein optical transmitter 38 and receiver circuit 110 are configured to transmit via a capacitive coupling, an LF signal, wherein the optical transmitter 38 and the receiver circuit are replaced with an LF transmitter and receiver respectively, or a radio frequency signal, wherein optical transmitter 38 is replaced with an RF transmitter and receiver circuit 110 is an RF receiver circuit. In an alternative embodiment, where a radio frequency signal is used to communicate the activation signal characteristic between the trainable transceiver 12 and the portable transceiver 13, the transceiver circuit 54 and antenna 56 may be used to transfer the activation signal characteristic(s) to the portable transmitter 13. Alternatively, receiver circuit 110 can be a broadband receiver configured to receive signals at any of a plurality of frequencies, or a fixed frequency receiver circuit. Either of the fixed frequency or broadband receiver circuits have lower costs and are simpler to construct than a tunable receiver, although a tunable receiver can also be used in some embodiments. Preferably, either optical or radio frequency methods are used, since trainable transceiver 12 is configured in commercial embodiments with the proper hardware for such communication. In another embodiment, portable transmitter 13 can be configured to receive any type of signal which conveys at least one characteristic of the activation signal of original transmitter 102.

[0031] According to one advantageous embodiment, portable transmitter 13 comprises a housing configured as a key fob.

[0032] According to a further advantageous embodiment, trainable transceiver 12 can be configured to receive remote keyless entry data from a remote keyless entry transmitter, to store the remote keyless entry data, to transfer the remote keyless entry data to the portable transmitter 13. The portable transmitter 13 may then be used to retransmit the remote keyless entry data, for example, in response to an actuation of operator input device 106. In this manner, portable transmitter 13 can be configured to transmit an activation signal to operate home electronic system 18 in response to a first operator input device actuation (e.g., a first button), and, in response to second operator input device actuation (e.g., a second button), portable transmitter 13 can be configured to transmit a remote keyless entry signal to allow an operator to gain access to vehicle 10 (FIG. 1). The remote keyless entry transmitter that the portable transmitter 13 is training to can comprise a housing configured as a key fob. Portable transmitter 13 can be configured to store a plurality of remote keyless

entry signals, each of which can have a different data code, modulation format, and/or frequency, etc. In this manner, a single portable transmitter can be configured to transmit activation signals or other wireless signals to control garage door openers, home lighting, wireless door locks (vehicle or home/office), security systems, etc.

[0033] According to one exemplary embodiment, trainable transceiver 12 is fixedly coupled to a vehicle interior element. This fixed coupling provides a convenient location for a trainable transmitter in vehicle 12, and further prevents an operator from losing, misplacing, dropping, or otherwise losing control of trainable transceiver 12. The term "fixedly coupled" refers to the characteristic that trainable transceiver 12 is not removable from the vehicle interior element, though it may be moved within the vehicle interior element (for example, in a sliding configuration).

[0034] According to one exemplary embodiment, portable transmitters can comprise a housing formed as a key fob, which is typically curved and smaller than a conventional, square original transmitter.

[0035] According to one advantage, portable transmitter 13 provides portability of the characteristics of the activation signal stored by trainable transceiver 12, but is less expensive in some embodiments, such as, those embodiments wherein low-cost parts are used, such as a transmitter instead of a transceiver or a frequency-agile transceiver. In one inexpensive embodiment, receiver circuit 110 of portable transmitter 13 can be a simple radio frequency field detector, such as, a detector comprising or consisting of a coil, a diode, and a capacitor.

[0036] According to one exemplary embodiment, portable transmitter 13 clones itself from trainable transceiver 12, which means that data is transferred from trainable transceiver 12 to portable transmitter 13 sufficient to replicate the control data and frequency of an activation signal sent by original transmitter 102.

[0037] According to one exemplary embodiment, portable transmitter 13 is smaller and more portable than trainable transceiver 12.

[0038] According to alternative embodiments, the training or cloning process between trainable transceiver 12 and portable transmitter 13 can be activated in response to a manual press of operator input device 32, by establishing a physical, wired connection between

trainable transceiver 12 and portable transmitter 13, or automatically, wherein trainable transceiver 12 transmits data upon activation at operator input device 32 and portable transmitter 13 maintains receiver circuit 110 in an always-on mode, wherein it is configured to receive data from optical transmitter 38 on trainable transceiver 12.

[0039] According to alternative embodiments, portable transmitter 13 can be configured to receive data that represents a characteristic of either fixed code or rolling code remote keyless entry data from the trainable transceiver 12. Rolling code systems utilize a secret encryption key and a rolling counter to encrypt the information. Control circuit 104 can be configured to operate with such rolling code systems. The encryption key can be preprogrammed into control circuit 104 or, perhaps, learned by control circuit 104 from the signals transmitted from trainable transceiver 12.

[0040] According to one exemplary embodiment, the different wireless control signals will be transmitted in the order in which they were selected during training. According to an alternative embodiment, trainable transceiver 12 can be a source device which is not trainable or not a transceiver (e.g., where the source device can be manually programmed).

[0041] While the exemplary embodiments illustrated in the FIGS. And described above are presently preferred, it should be understood that these embodiments are offered by way of example only. For example, alternative embodiments may be suitable for use in the commercial market, wherein office lights or security systems or parking garage doors are controlled. Accordingly, the present invention is not limited to a particular embodiment, but extends to various modifications that nevertheless fall within the scope of the appended claims.

VIII-3-1	**Declaration: Entitlement to claim priority** Declaration as to the applicant's entitlement, as at the international filing date, to claim the priority of the earlier application specified below, where the applicant is not the applicant who filed the earlier application or where the applicant's name has changed since the filing of the earlier application (Rules 4.17(iii) and 51bis.1(a)(iii)): Name:	in relation to this international application JOHNSON CONTROLS TECHNOLOGY COMPANY is entitled to claim priority of earlier application No. 60/424,989 by virtue of the following:
VIII-3-1 (iv)		an assignment from BLAKER, David, A. to JOHNSON CONTROLS TECHNOLOGY COMPANY, dated 09 January 2003 (09.01.2003)
VIII-3-1 (ix)	This declaration is made for the purposes of:	all designations